



THE MEMBERS MAGAZINE OF THE NATURAL
HISTORY MUSEUM OF LOS ANGELES COUNTY

Terra

VOL. 16/No. 2 FALL 1977

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The Cover

A section of the new WHARF PILING DIORAMA in the new Hall of Marine Biology at the Museum. Wharf pilings serve as homes and feeding places for many plants and animals. Animals on pilings depend on

currents to bring food within their reach. Frequently life becomes so abundant on a piling that it is like a complex apartment house setting; the mass of encrusting life forms a fascinating interdependent community. This diorama is based on Long Point—Palos Verdes Peninsula.



The Members Magazine of
THE NATURAL
HISTORY MUSEUM ALLIANCE
of Los Angeles County
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The waters of the earth held little more than the simplest bacteria and slimy blue-green algae 3.2 billion years ago. These conditions probably lasted for 2.5-billions of years, but the restless sea was preparing for a future explosion of life on an enormous scale. About 750 million years ago, at the end of the era we call the Precambrian, life began its spectacular diversification. At this time probably all of the major animal phyla were represented, but they doubtless were of simple, frail and soft-bodied construction. From these primitive forms came a profusion of shapes, colors and styles; and the biological destiny of life on earth began.

Nowhere was the explosion of living forms greater than in the ocean. The sea is home to an overwhelming multitude of curiously-diverse and wondrously-formed organisms, where primitive bizarre creatures as well as the relatives of the terres-

trial colonizers still exist. At first glance the fantastic array of life in the sea is staggering, but upon a closer and more intimate examination the colors, shapes and life styles merge into recognizable associations that we call habitats.

Perhaps all of us are familiar with the rocky coasts. Here when the tide is high on a rocky shore, its brimming fullness creeps high onto the land, and on first appearance one might suppose that nothing lived in, on or under these waters of the sea's edge. Here nothing seems visible. High tide is a quiet peaceful time. Nothing is active save for a small group of gulls that rest on ledges of rock, high above the surf and spray. The gulls wait, their yellow bills tucked beneath their feathers, and doze away the hours of the incoming, rising tide. All of the creatures of the tidal rocks are hidden from view, but the gulls know that in time the waters will

recede and expose the intertidal life zone.

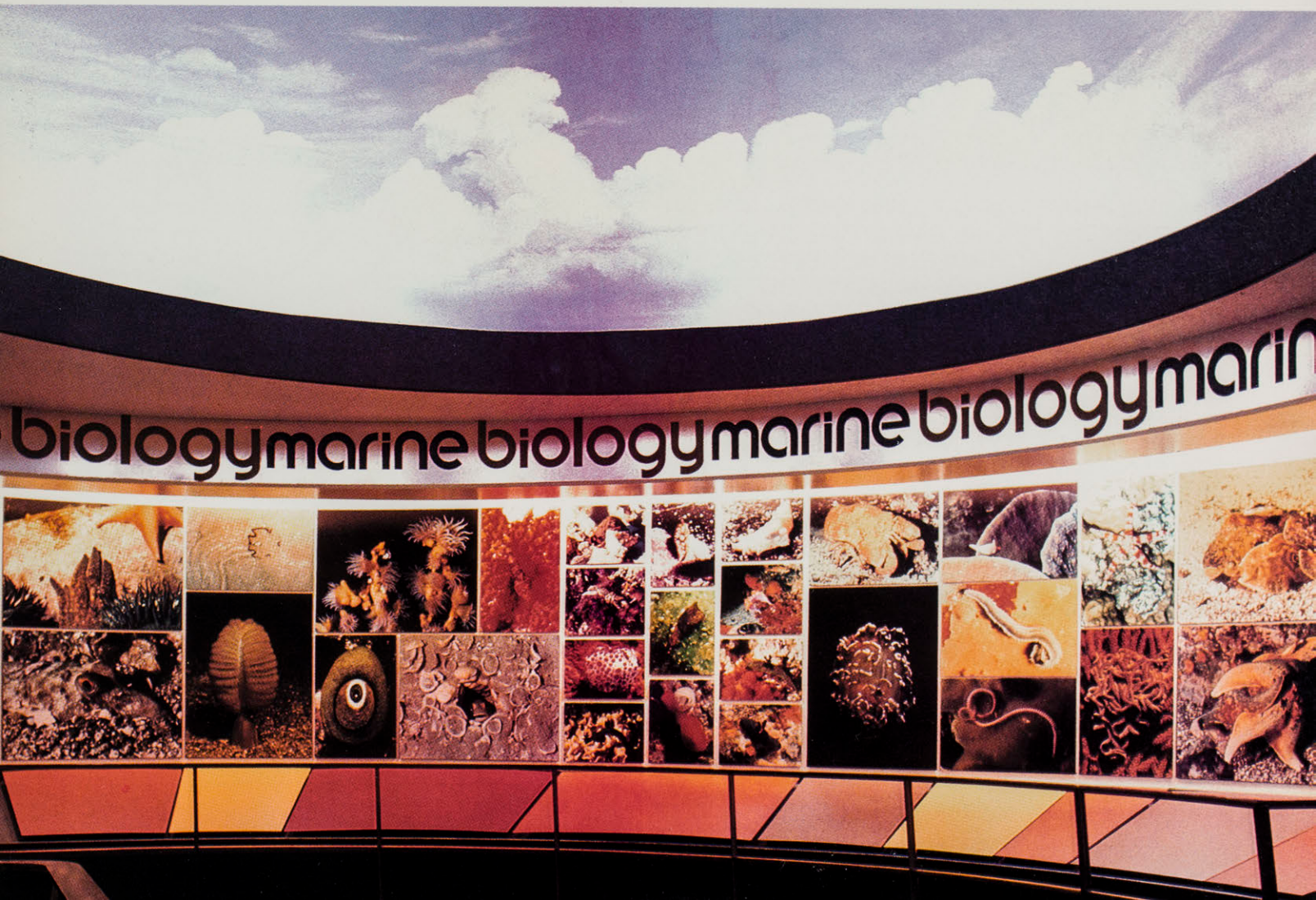
As the ocean rolls back and exposes undersea life it does so in a peaceful manner, which is quite different from the rising tide. On incoming tides the shore is a place of unrest as the surge leaps over jutting crevices and rocks, and runs wildly about in lacy cascades of foam.

The drama of the turning of the tide begins slowly as a narrow zone of wetness appears on grey rocky slopes. Then, in the offshore incoming swells hidden ledges appear and waters begin to swirl and break over them. Finally, rocks that were completely concealed from view by the high tide rise into view and glisten with the wetness of receding water in the sunlight. Now the intense beauty and spectacular array of marine life comes fully into view with a stunning reality.

The pattern of life spread before you in

the world of waters wild

by Robert J. Lavenberg and Camm C. Swift



the charm and grace of the intertidal zone is only a tiny fraction of life in the sea. Along the fringes of the ocean the life of the land grades into the life of the sea. Here is the recognizable habitat called the intertidal zone. Here the many kinds of life in the sea live out their lives in a horizontal zone created by the tides. In little pockets or in crevices there are groups of animals established by the need to take shelter from the surf, or to find food, or to hide from their enemies.

From the edge of the sea, out to its lonely open expanses, and down into its hidden depths the new Hall of Marine Biology at The Natural History Museum of Los Angeles County attempts to provide some of the answers to the mysteries of "Life in the Sea." It was just last month, on October 12, that the Life Sciences Division of the Los Angeles County Museum of Natural History

opened a major exhibit in the marine sciences. This is the third marine-oriented exhibit in the history of the Museum and replaces two earlier ones that opened in 1925 and 1930 respectively.

Upon entering the new exhibit area, a grey carpet spreads forth like a layer of encrusting sea mosses, and a photographic mural emblazoned with the fiery colors of marine organisms immediately establishes a theme and a mood. The intense beauty belies the calm represented in the stillness of the mural as the struggle to live and survive is a primary one in the ocean. The theme is to present organisms in their environment. The mood is life and death.

The word biology is derived from the Greek language meaning "life" (*=bios*) and "study" (*=logia*). Therefore, biology is the study of life and is the science of living matter with reference to its origin, growth,

reproduction and structure. That branch of biology treating the relations between organisms and their environment is called ecology, which also is derived from the Greek language meaning "home" (*=oikos*) and "study" (*=logia*). The Hall of Marine Biology portrays "Life in the Sea" in a manner that shows different kinds of plants and animals as well as their place in the environment. We have attempted further to stress ecology, which is concerned especially with the biology of individual organisms or groups of them in conjunction with studies of existing conditions or changes taking place on land, in freshwaters, or in the ocean. Marine ecology is the application of this science to the marine environment. Today, even as in earlier primitive societies, survival of individuals depends upon their knowledge and understanding of the environment. In this exhibit,



Marine plants reproduce in a way that differs from animals by having two generations, a microscopic one and a macroscopic one. This type of reproduction is called alternation of generations. It is shown here as an overlay in front of a macroscopic marine plant.

we provide the viewer with some insight into the world of waters wild: life in the sea.

Marine biology encompasses all that is alive in the sea, and life exists throughout the world's oceans, including many obscure and inhospitable corners. The oceans, at least as we know them, may be as old as earth, about 4.5 billion years, and during these eons of time millions of plants and animals have evolved. Many tiny one-celled organisms even seem to bridge the gap in separating plants from animals. To portray all of this within the limits of one moderate-sized exhibition hall is impossible, but many facets of life of the ocean are displayed. Our new hall goes much beyond the mere display of specimens and provides an exciting mini-course in marine biology. The hall is designed not only to show a cross section of southern California marine life but all major oceanic life zones with a series of marine

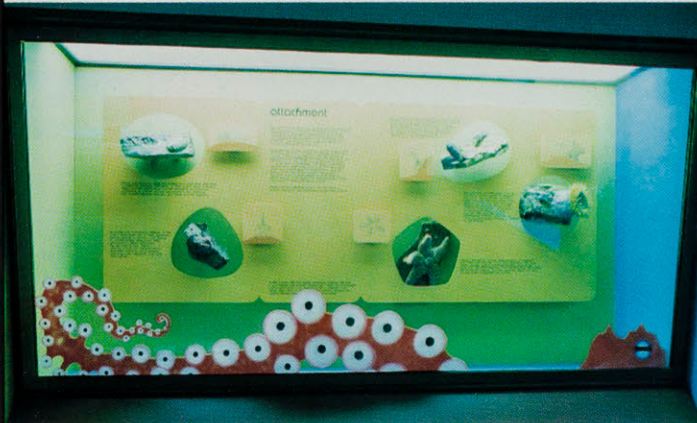
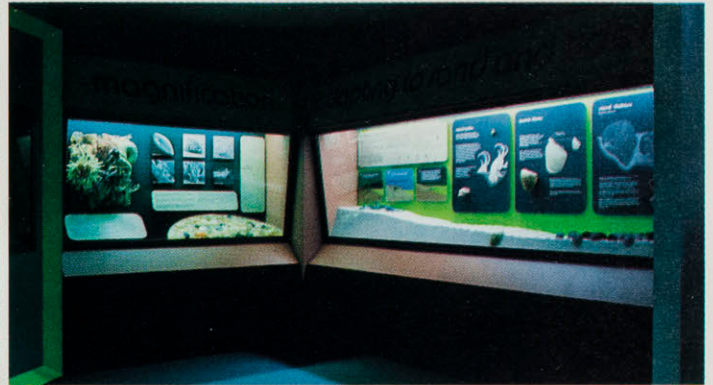
habitats reconstructed in their entirety. A person's exploration of the ocean starts at the shore and moves seaward. Down through history man progressively investigated deeper waters as his technical capabilities improved. The major features of the marine hall, the large dioramas of various marine habitats, progress from shallow waters (Estuary and Rocky Intertidal) into deeper ones (Offshore Reef and Abyss). Each of these dioramas vividly thrusts the visitor into a portion of the ocean. A guide to the plants and animals of the habitat is provided, and smaller cases further dissect the habitats into interesting components that are not visible by simple observation. Again, as man became more curious about his environment he delved more deeply behind the scenes to discover many hidden secrets, and many of these are shown in the smaller display cases.

The beginning of the exhibit stresses the beauty and intrinsic interest of marine animals in photographic murals, the methods of research and investigation used by marine biologists, and the nature and geologic history of the Pacific Ocean, particularly the configuration of the California coastline.

The dioramas provide the nucleus of this hall, the philosophy of which is to provide a holistic view of marine life. Thus one need not even read to experience and enjoy the diversity of the marine environment that is the heart of the Hall of Marine Biology. However, the more sophisticated and inquiring visitors have many more details to satisfy them. Did you know that sharks have seven senses, and can even detect small electrical charges? Have you heard the story of the innkeeper worm so common on California mudflats? Has the area around Marina del Rey changed much in the last

Feeding. Marine organisms from the mud-eaters to the great predators feed in an unbelievable number of ways. This display explores food and feeding.

Magnification. Tiny forms of marine life are magnified so that they may be seen by the viewer. The stunning 15-times-actual-size model on page 7 from this display emphasizes the tiny marine creatures. The other case shows marine adaptations to sandy habitats.



Attachment. Only those marine plants and animals that have developed special methods for attaching themselves to rocky surfaces can withstand the constant impact of crashing waves.

Marine Terrain. This exhibit explains marine tectonics, water circulation, and currents.

fifty or sixty years? All of these and many other questions are answered in this hall, which will occupy many hours of any visitor intent on acquiring the whole marine biology lesson in one visit.

Six dioramas emphasize the environment and provide looking-glasses into the major marine habitats throughout the world. Estuary, wharf piling/sand beach, intertidal, offshore cliff, oceanic bank, and abyssal habitats are each recreated from a specific locality with exacting detail for scientific accuracy. Specialized lights and recorded sounds attempt to bring each diorama to life to make the viewing a sensual experience.

The first diorama is an estuary where fresh and salt water mix, one can almost imagine trudging through the soft, sticky mud, and smelling the foul odor of hydrogen sulfide that comes from the decaying remains of plants and animals. The estuary or

salt marsh is of upper Mugu Lagoon, one of the few remaining natural estuaries left in southern California.

The wharf piling appears to be just beyond touch in an underwater world wherein man is only a visitor. The piling was based on one from the pier at Marineland.

As if the ocean has rolled back from the shore, the intertidal lies exposed to view, and the visitor can visually explore the undersea life that flourishes there. A Palos Verdes Peninsula tidepool served as the model for this diorama.

A subtidal cliff extends upward as if to reach to the surface, and the entire face of the cliff is covered by encrusting organisms, plants and fishes. The spectacular Blue Caverns area of Catalina Island is reconstructed in this diorama.

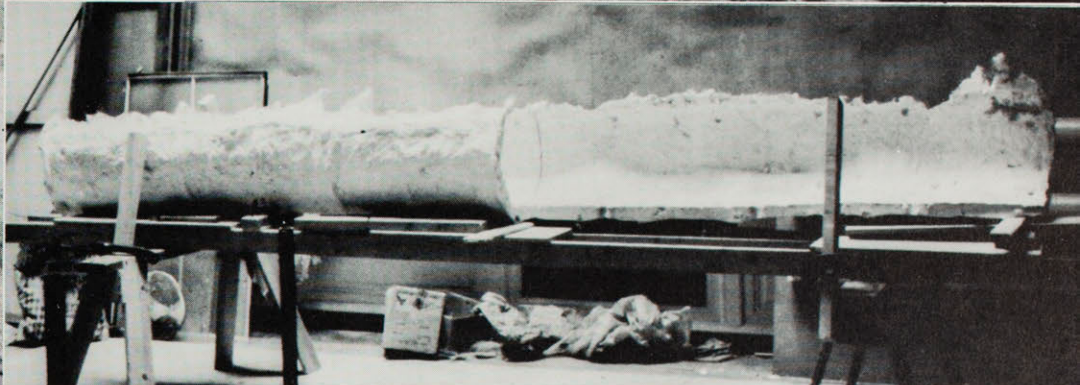
The pinnacle of an oceanic bank abounds with marine life and demonstrates the opu-

lence of nature in a bewildering way. About three miles southwest of Catalina Harbor, on the backside of Catalina Island, a pinnacle of rock rises to within about sixty-five feet of the surface called Farnsworth Bank. This beautiful spot could only be appreciated by scuba divers until this diorama was completed.

Walking into the darkened surroundings of the abyss gives a cold feeling, and one can imagine descending into the great oceanic depths where bizarre creatures lurk about in the darkness as if out of a bad dream. The abyssal diorama is unique among Museum exhibits, and was in many ways the most challenging. It demonstrates a deep-sea habitat that no man had seen directly when the diorama was first conceived. Even now only a few men who have descended in deep-sea submarines have witnessed the creatures of the deep. Much



Estuary Diorama. An estuary is a place where fresh and salt water mix. It is a semi-enclosed coastal body of water with a free connection to the open sea, and within which sea water is diluted with fresh water derived from land drainage. The mud or sandy bottom of an estuary determines which plants and animals live there. This diorama is based upon the Point Mugu estuary.



Clockwise, from upper left:
Piling from Los Angeles Harbor selected for the diorama in wharf piling group.
Outer protective cast partially finished. Inner coats actually form all the characteristics of the piling.

Removed cast of the pile being reformed. Inner latex coat to be placed inside this shell and filled with model compound.
Details of the foreground preparation in the Wharf Piling Diorama.

Details of background being painted in by Exhibitions artist.
A 15-times enlarged fiber-glass and plastic model of a one square inch section of wharf piling. This model features a barnacle, sea anemone, moss animals between the two, tubed snails and two caprellid shrimp on hydroid animals.

Offshore Reef Diorama. The ocean is like a circulatory system for the reef and its creatures. The animals on the reef are unable to move and they depend on water to support them. This diorama is based on Farnsworth Bank, Catalina Island.

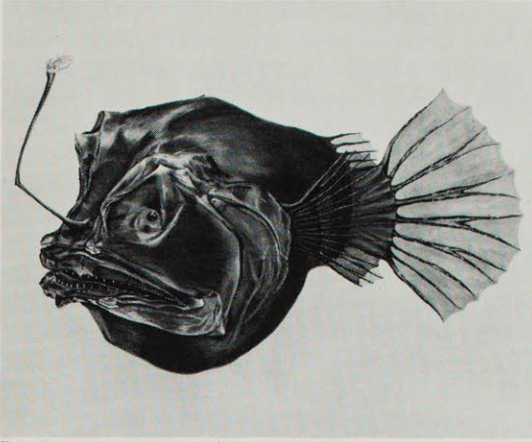




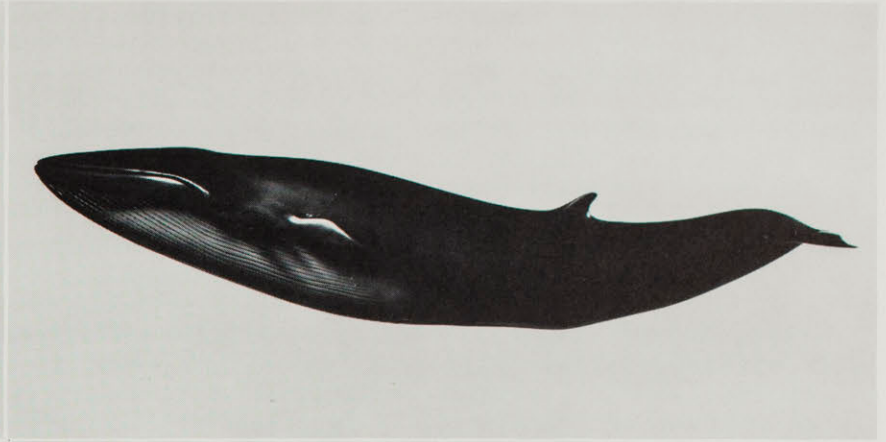
Rocky Intertidal Diorama. The intertidal zone is roughly that area of oceanic shoreline between mean high tide and low tide. Intertidal zone organisms survive by anchoring tightly to avoid crushing waves, and by having some means of avoiding drying up. This diorama is based on Portuguese Bend.

Subtidal Cliff Diorama. Beneath the turbulent intertidal zone wave action stops and the subtidal zone is a place of quiet waters. A subtidal cliff is a precipitous nearshore drop-off from the shallow intertidal zone to deeper waters. This diorama is based on Blue Caverns, Catalina Island.

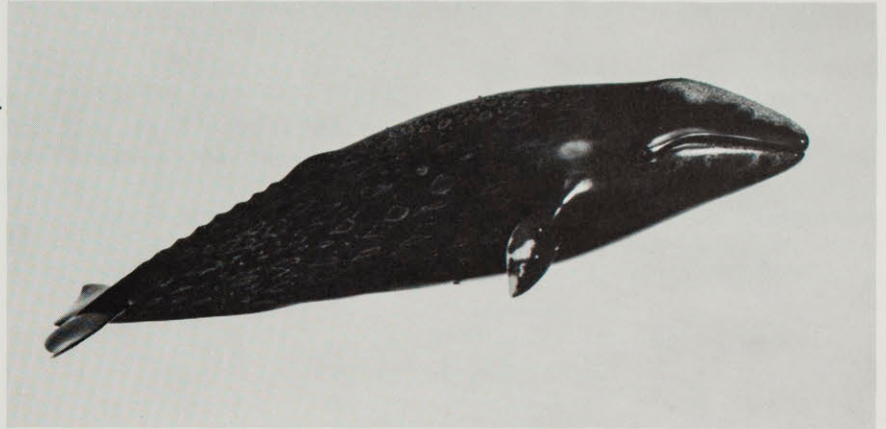




Pacific dreamer anglerfish, *Oneirodes acanthias*, is one of the fishes featured in the Abyssal diorama.

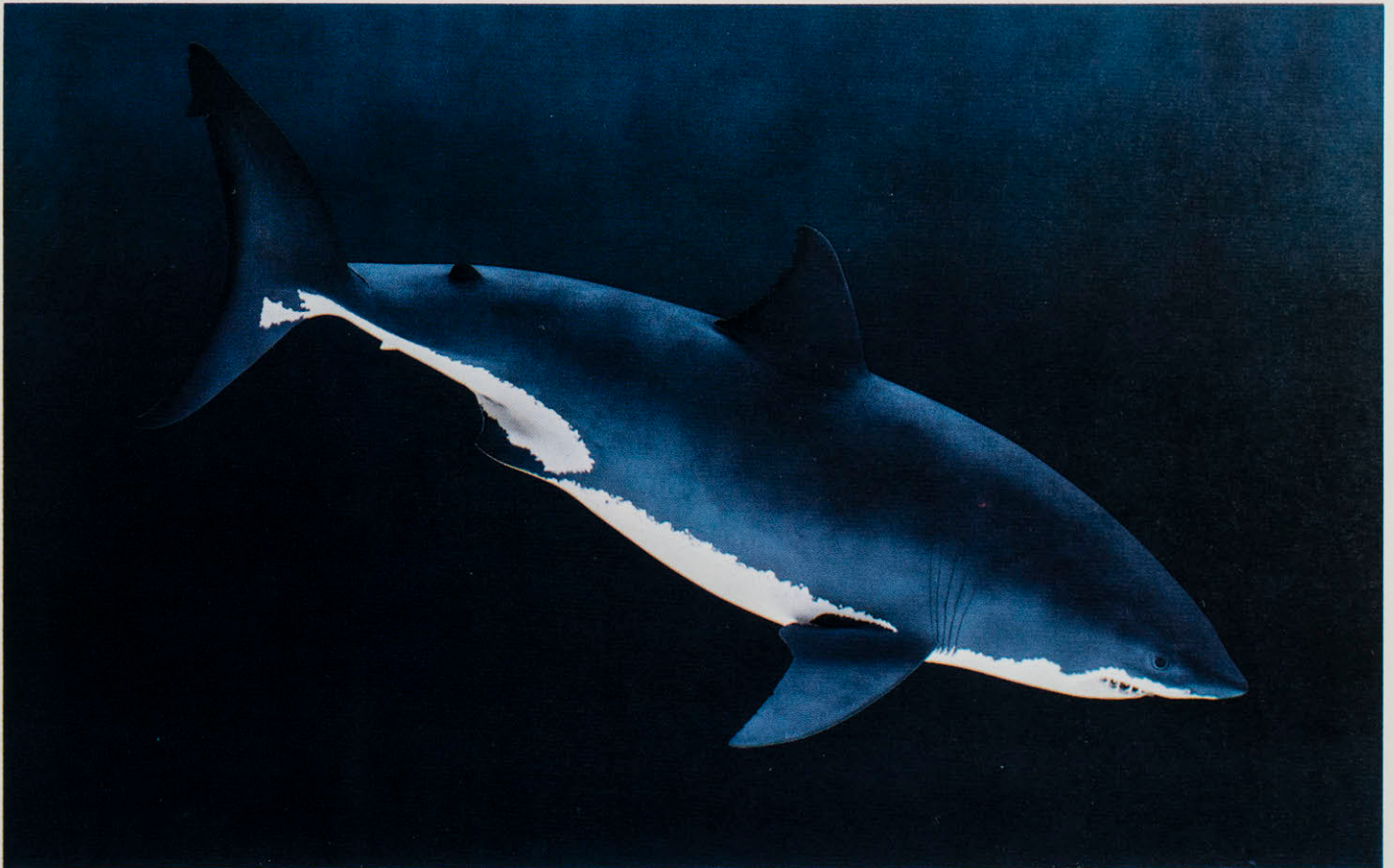


Finback Whale model.



Gray Whale model.

The White Shark



of this diorama involved piecing together the results of the catches of nets and trawls.

On the north wall opposite the dioramas, a series of small cases treat special topics: a series of mini-dioramas depict the sequence of events during the nesting of a green sea turtle; a little theater shows green sea turtles on the Great Barrier Reef; another case illustrates the strategy of the tuna fishermen in following the porpoises to capture tuna; marine algae, living fossils, marine boring organisms, a gigantic tuna skeleton, and poisons and venoms highlight several other cases. Four little theaters show spectacular views of living marine organisms, including exceptional ones of deepsea forms.

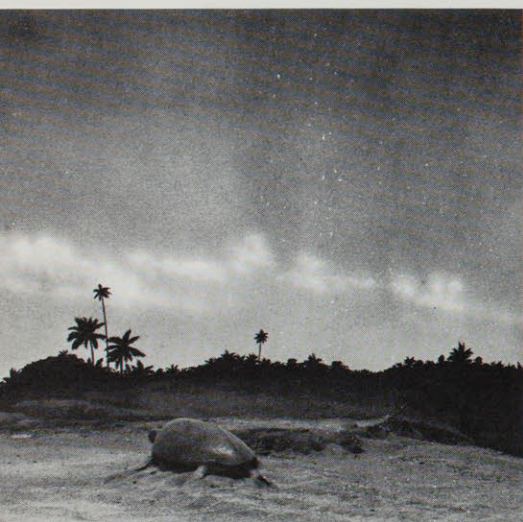
High along the north wall are several large marine fishes and two sea turtles. Of these the Pacific Oarfish and the White Shark probably will compete for the title of most popular fish. The Pacific Oarfish has been a display attraction at the Museum for seven years, since its capture at Leo Carillo State Beach. The White Shark needs no

explanation for its popularity. As you look up at these fishes, pay special notice to the ceiling, which portrays the view of waves as viewed from under water. Only then do people realize they have been under water all the while, and it takes an experienced diver to look up and tell which way the wind is blowing at the surface!

This entire exhibit has been accomplished through the energies, contributions and dedication of the Museum staff. The cooperation from many other agencies and individuals has aided us enormously in the preparation of the Hall of Marine Biology. On one occasion more than twenty scuba divers from the Museum, the California Department of Fish and Game, Scripps Institution of Oceanography, and the Catalina Marine Science Center blanketed Farnsworth Bank for the purpose of getting materials to construct a diorama as well as to obtain information necessary to establish this unique area as an Ecological Preserve. In our research, several kinds of marine life previously unknown to science were dis-

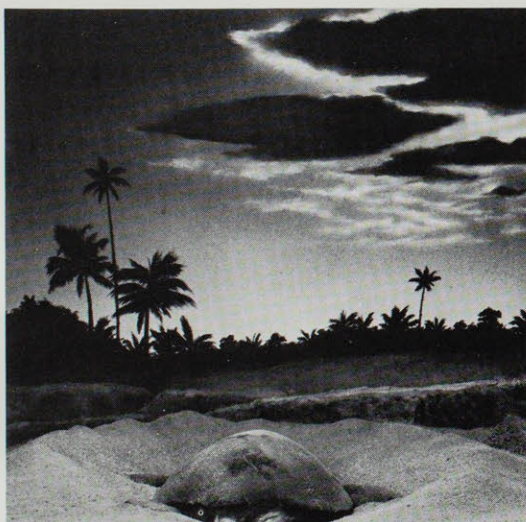
covered on this bank, including two species of fishes. Another time a Los Angeles resident called to ask if the museum could use a Giant sea bass, weighing 110 pounds, which he had caught the previous day. The Giant sea bass on the north wall was made from this specimen. Many photographs and specimens have come from amateurs and professionals alike. Two very important components have been the collective acquired knowledge of marine biologists, both published and unpublished, which forms the basis of the information presented, and the skill and artistry of the Museum's exhibit staff in presenting this information. Several years of concentrated work are represented in this elaborate hall and most of it is due to the staff of the Exhibitions Division.

Rather than remaining static, the Hall of Marine Biology will continue to grow and change as our knowledge improves. One additional diorama, a coral reef, and associated cases are under preparation in the area east of the present hall beyond the abyssal diorama. This addition will take the

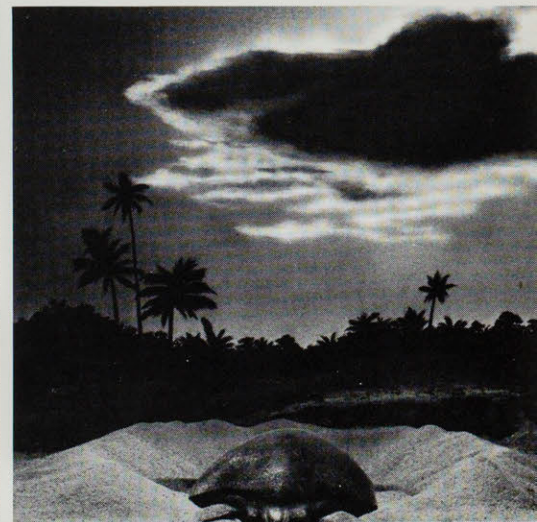


Sea turtles, with their flipper-like forelimbs and streamlined shells, are among the most marine-adapted of living reptiles. Yet to nest they must leave the relative safety of the sea and return to their ancestral home on land. The six dioramas in the new Marine Biology Hall demonstrate the process:

This green turtle, *Chelonia mydas*, cautiously emerges on a Costa Rican beach.



The turtle, after propelling her 350-pound body high up the beach, hollows out a resting place with her front flippers, and carefully scoops out an urn-shaped nest with her hind feet.



Her eyes streaming with tears, the green turtle lays about 100 golf ball-sized eggs in twenty minutes.

visitor southward to southern Baja California to the warm tropical, coral environment visited by many southern Californians. Much of the coral has already been collected and this addition should open in one or two years. The opening of the Hall of Marine Biology is a major event in the Museum's exhibit program; the hall will be extensively utilized since very little other marine information is available in the Museum. We hope that the hall stimulates curiosity and respect for the marine habitat. One visiting teacher commented that with the environment deteriorating so fast the Museum would soon be the only place to bring students to view what we have lost. Further, we hope that the hall will help to impress people with the importance of the sea, cause a renewed interest in protecting the ocean, and prevent its ultimate deterioration.

Historically the disciplines that comprise all of what is marine biology have had little exposure at the Museum. Marine sciences became a reality at the Museum on August

16, 1922 when Howard R. Hill became its first zoologist. Some years later, on November 27, 1925, the first marine-oriented display opened and featured row upon row of cases exhibiting row upon row of specimens. This temporary show of marine shells was replaced by a series of dioramas collectively called the Hall of Marine Life on November 7, 1930. The Hall of Marine Life emphasized the environment off southern California, and closed in the summer of 1965.

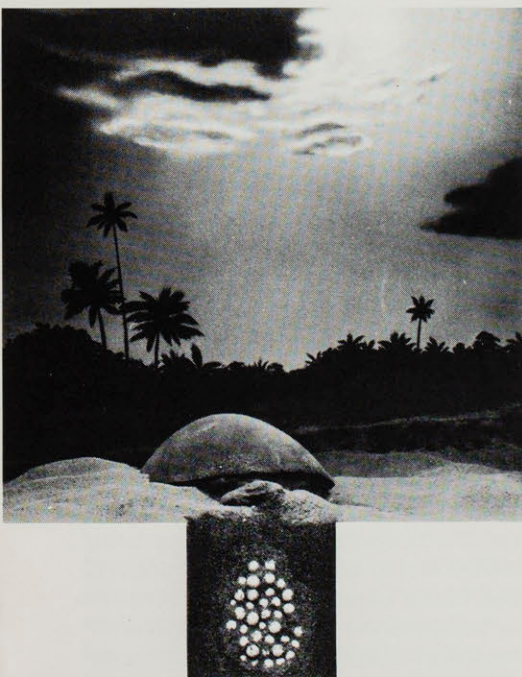
Our new exhibit features the entire marine world in dioramas and explanatory cases. After the plans were drafted and approved in 1963, the Hall of Marine Biology spent its infancy in construction through the late sixties and into the seventies. The individual dioramas were built to exacting specifications; and scientific accuracy has never been sacrificed. As a result the dioramas represent an enormous investment, which show an unparalleled creativity and artistry. Marine Biology at the Natural History Museum comes of age with the

opening of this comprehensive exhibit into the World of Waters Wild.

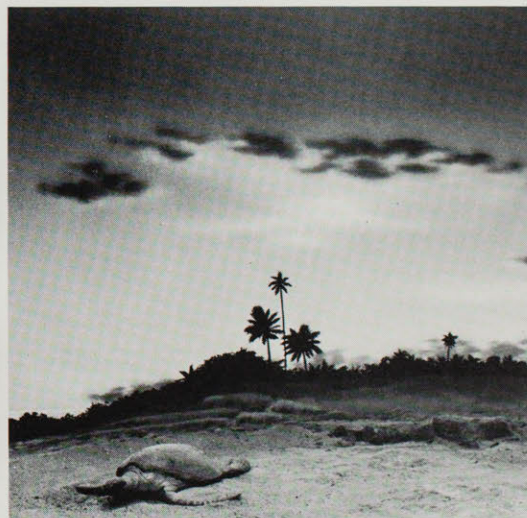
We expect the Hall of Marine Biology—Life in the Sea to be one of the most popular exhibits in the Museum. You are invited to visit your Natural History Museum and be our guest in experiencing and discovering the mysteries of life in the sea. The presentation of this exhibit has been aided by the advice and assistance of many colleagues. To all of those individuals who have labored with us to produce this story of marine life we extend our sincere appreciation and gratitude. We especially thank the Staff, Administration, Trustees and Governors of the Museum for their support of this project.

Robert J. Lavenberg and Camm C. Swift are curators of Ichthyology at the Natural History Museum of Los Angeles County. Lavenberg's research deals with the ecology and evolution of oceanic and near-shore fishes, particularly those of the eastern Pacific Ocean. Swift specializes in the study of fish osteology (skeletons and bones), and in the biology and distribution of freshwater fishes.

Photos in this article are by Larry Reynolds.



She then covers her nest with sand. The eggs are highly sought after by humans and other animal predators. After a day or two the nest will be undetectable.



The spent female leaves the eggs to incubate in the nearly-constant temperature of the moist sand, and returns to the sea where she will regain her strength by grazing on marine algae.



After sixty days eggs begin to hatch. When all the siblings have escaped from their eggs, as a cooperative group they make their perilous journey out of the nest, down the beach, and into the protective waters of the sea.



BEAUTY of the BEAST

THE ANIMAL IN ART

by **Herbert Friedmann**

The leopard in the title is painted by Geoffrey Roberts-Coe. It has been reproduced as a poster available at the Natural History Museum's Bookshop for \$3, plus tax.

"The Beauty of the Beast: The Animal in Art," the special exhibition currently at the Natural History Museum of Los Angeles County, has been designed to illustrate mankind's age-long and ever-continuing interest in the many kinds of animals that share the planet with us. Concurrently, in some thirty museums throughout the world related but independent displays are being staged in conjunction with the World Wildlife Fund, an international organization concerned with the conservation of endangered species of animals everywhere.

Throughout his millions of years, man has had a vested interest in animals. Some he hunted and killed for food or clothing; others he killed rather than be killed. Yet his interest in animals seems to have been more than utilitarian, judging from his early attempts to depict them.

Animals would hardly seem worth the effort to portray them if they were merely objects of food or of danger. After the first civilizations arose animals, among other natural objects, became common as visual symbols of concepts not readily conveyed in words, especially to largely nonliterate populations. Symbolism was employed as a communicating device for many centuries, particularly in the dissemination of ethical and religious thoughts. For instance, the fish was one of the earliest symbols of Christianity. Animals as symbols were adopted and adapted by successive cultures, often with marked changes in meaning, but still intelligible to the viewers. Even today, we have not entirely ceased using animals as symbols; our two leading political parties are immediately identified with pictures of the donkey and the elephant, and our country by a bird.

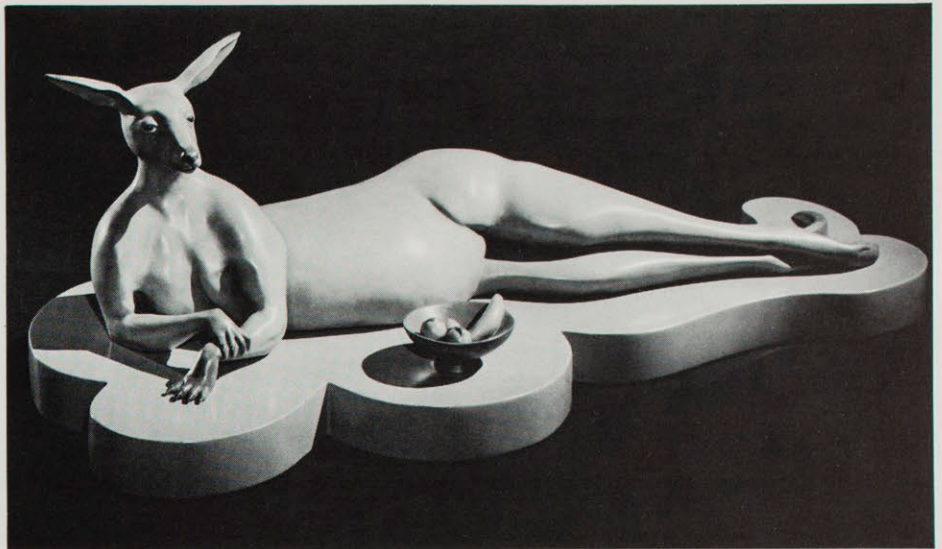
Involvement with animals on all levels of thought has been shown by peoples of all areas and all classes, whether tribal villages or developed nations. Animal images have been painted on walls of caves with vegetable and mineral dyes, and on canvases with the most complex oils. They have been woven into enormous tapestries covering cold castle walls and stitched onto small childish samplers. They have been sculpted in clay, carved in stone, ivory, and wood, cast in ceramics and metals, woven into baskets and etched in illustrations for books. Marine life has been carved on bone in the art of scrimshaw, as artistically inclined seamen used to while away tedious time at sea. Whether in swords or ploughshares animal faces have been featured on metal work from brilliant Scythian gold to American pewter. Animals observe us from coins, cups, buckles, and buttons. They tower on totem poles and monumental

sculptures, or take refuge in minute designs in lace and jewelry. Animals are everywhere in art. They form the basic motif of man's natural desire to decorate, a desire taking substance mainly from powers of observation coupled with imagination.

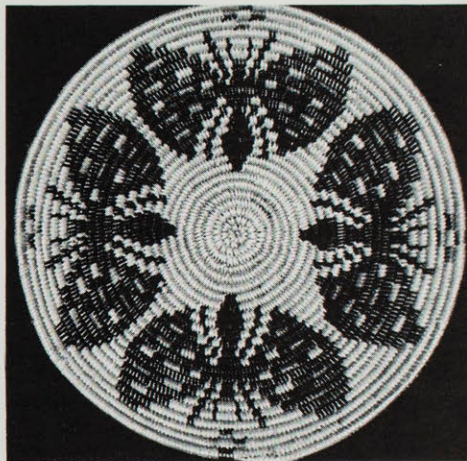
Inasmuch as man's art goes back much farther than his written word, and inasmuch as pictures need no translators to make them meaningful, as would the many languages in which animal subjects have been described, it is to the pictorial record that we may look for a clear and yet comprehensive expression of this interest in animals.

Man's concern with beasts, birds, butterflies and other creatures is a vital part of the intellectual scope of a natural history museum. In planning the present exhibition it is our thought that we are merely showing another aspect of this basic interest, an interest we ordinarily take so completely for granted that no explanation seems necessary. The World Wildlife Fund hopes through this, and similar displays, to add to its members and resources. The number and variety of situations in need of support is increasing more rapidly than its present ability to respond with needed personnel and funding. When a species of animal or plant is seriously endangered, its possible survival usually necessitates prompt and sufficient assistance: a mere resolution of concern or of sympathy is no help to a vestigial population foundering on the brink of extinction. While natural history museums have as part of their program the conservation and exhibition and study of specimens of animals, they share wholeheartedly with The World Wildlife Fund the desire to protect and assure the survival of the living stocks of these same creatures. Museums must preserve and display examples of animals that have become extinct, as it is only in such institutions that they may now be seen, but there is always an element of sadness involved, and, in the case of species extirpated by human agency, an element of guilt and belated regret as well.

In recent years there has been a huge groundswell of interest in endangered species. Much thought, energy, money, and emotion is being spent to save from disappearance many creatures whose numbers have been decimated and whose habitats have been despoiled and greatly reduced by the aggressiveness and self-centered greed of man. The animals and plants that inhabit the world add greatly to its beauty, interest and potential. If mankind has only recently come to realize that it is to his own enlightened self-interest to preserve them, it is better to act on this than to wish it had happened sooner.



Odalisque by Sylvia Massey.

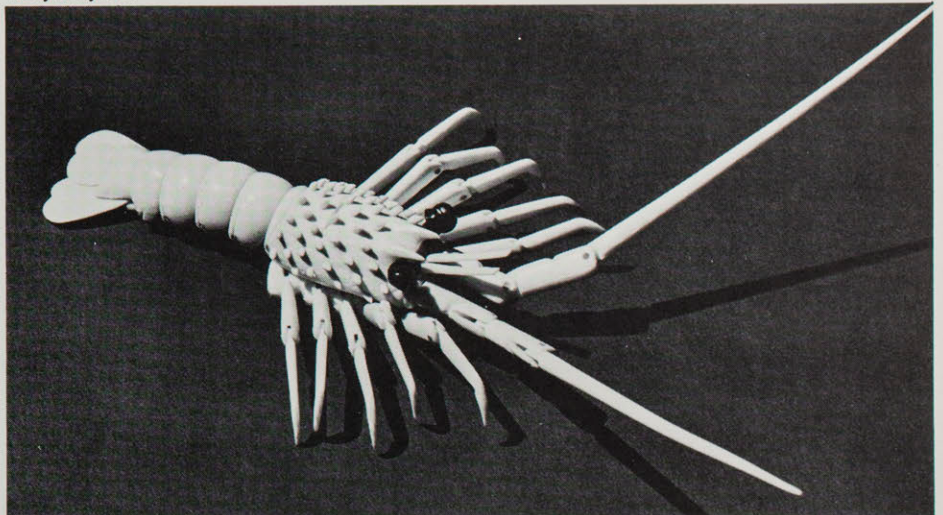


Basket, woven with butterflies. Mission Indian, California.



California Condor, now endangered.

Ivory crayfish.





Jaguar clay stirrup spout bottle,
Mochica, Peru.



Crocodile carved wood stool, Sepik
River, New Guinea.

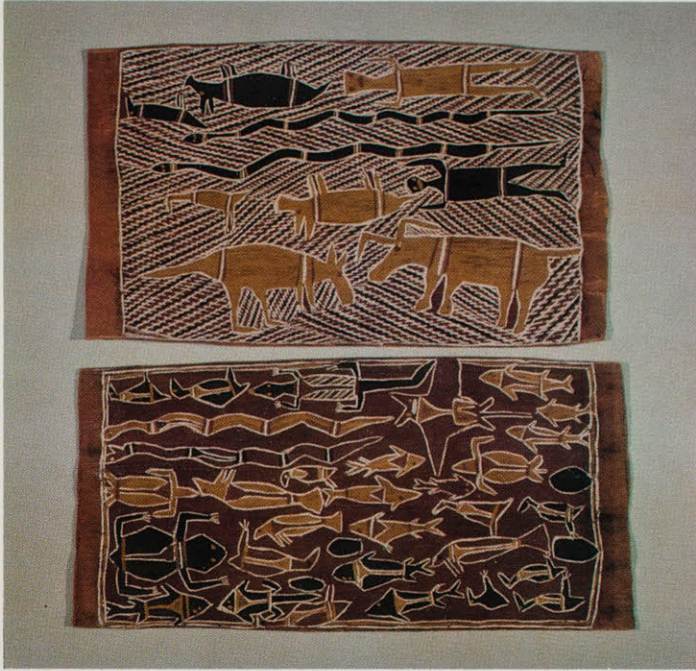
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Trogon Massena from *Monograph of
the Trogonidae*, by John Gould.



Wolf/crane shaman's rattle, Tlingit,
Canada/Northwest Coast.





Buffalo, kangaroo, fish, snake, bark paintings, Aborigine, Australia.

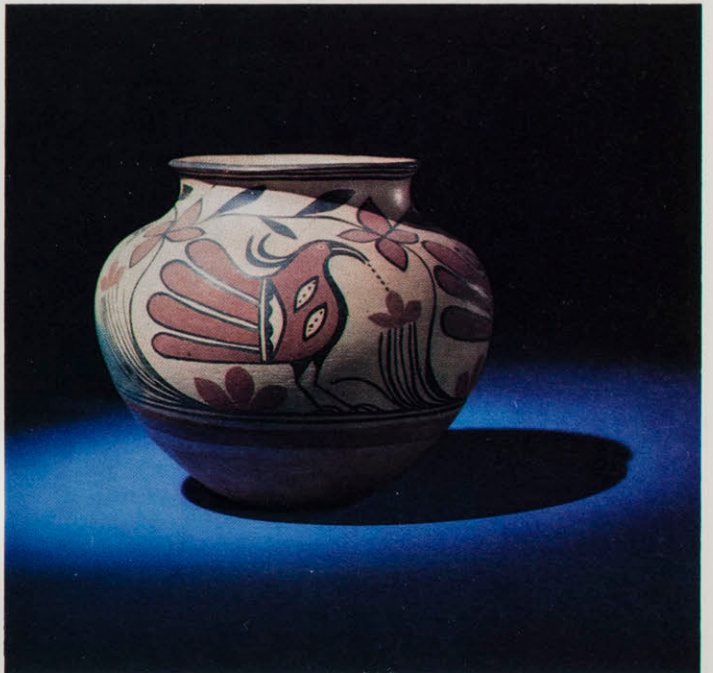


Turtle bottle, Colima, West Mexico.

Zuni bear fetish, turquoise, flint, coral, feather. New Mexico.



"Zia Bird" pottery jar, Zia, New Mexico.



Biologists are well aware of the fact that extinction is a normal part of animate being; no species goes on forever; but it is within our power to prolong their existence and thereby to give succeeding generations the pleasures we have known in contemplating many creatures currently faced with disaster. To do this involves the preservation of special environments, of habitats in which each of the endangered species may flourish, as well as protecting the remaining individuals from hunting or from starvation.

Because the conservation of endangered species is the main aim of The World Wildlife Fund, the present exhibit is confined to wild species represented in art. Domestic animals, such as horses, cattle, sheep, pigs, dogs, cats, and poultry have been left out; also purely imaginary or mythical creatures as centaurs, basilisks, unicorns, and harpies have been excluded, although they occur frequently in human designs. None of them is in danger of disappearing.

To supplement the diverse depictions of animals included in the present exhibit, we have added mounted specimens of some presently endangered or recently exterminated species. Thus, the California Condor and the Whooping Crane are included, both now reduced to only a few dozen living individuals, and also such a very local and potentially endangered creature as the Okapi, a strikingly-marked large animal occurring in limited numbers only in densely wooded parts of the northeastern portion of the Congo forest in central Africa. Among recently exterminated species shown are the Great Auk, the Passenger Pigeon, and the Carolina Parakeet, all North American birds, victims of man's thoughtless destruction.

The use of animal figures in art, in the present display, begins with the very earliest of known human attempts at large-scale decoration—the truly astonishing paintings made untold thousands of years ago by prehistoric men on the roofs and walls of a number of caves in Spain and France. We show two reproductions of parts of the famous pictures in the cave at Altamira. While these may lack complete accuracy of detail and of articulation, they are very spirited and convincing representations conveying a fine sense of movement and of life. That art of such excellence could have been produced so early in the history of man's efforts to raise himself above a mere animal existence recalls the old aphorism that almost before he was anything else man was an artist. Furthermore, of all the things man could have used in his art, animals were the first that he

chose to include. A much later, but in an aesthetic sense, more primitive, original rock drawing is shown, carefully removed from its site on San Nicolas Island, off the California coast, and estimated by archaeologists to have been incised about 900 A.D., by an Indian of the "Canaliō" culture. This depiction of a sharklike creature is a simple pecked or incised rendering—an art form very different from the paintings at Altamira, but still a significant example of "the animal in art."

The arrangement of objects in the exhibit reflects the fact that our museum is devoted to natural history rather than to art, although it is the depiction in art of the animals involved that is our immediate concern. Where a comparable display in a museum devoted mainly to art might group the pieces according to whether they are pictures or carvings, or by the human cultures represented, we have grouped them around types of animals, whether creatures of land, water, or air, and include a special group of endangered or recently eliminated species. In each category, animal renditions in as many media as possible are included.

There is a greater presentation of terrestrial creatures than of those of the water or of the air in man's art, although this is subject to much variation in different human cultures. For instance, Eskimo art is far more involved with marine creatures—seals, walrus, whales, and fish—than is Oriental, African, or pre-Columbian Meso-American art. There is much variation in degrees of naturalistic accuracy or artistic imagina-

tion depending on the nature of the pieces and the purposes for which they were created, as well as the state of knowledge available to the artists in different cultures.

What does emerge from all sections of the exhibit is the interest in animals that has always held an important place in human thought, an interest present in the art of all peoples at all times, although possibly less so in our own time than in earlier ages when life was lived closer to nature. This deep-rooted concern with animals should enlist our sympathy and our support for the conservation of the world's fauna, for our own sake as well as for that of posterity.

The assembling of carefully-selected pieces for the current exhibition was made possible, not only by the Museum's own collections, but also by the generous and enthusiastic cooperation of other museums, of private collectors, and of dealers. These kind friends of our Museum and of The World Wildlife Fund are indicated on the labels of each item displayed. Without their help the whole exhibit would not have been so richly interesting. The visitor may join with the staff in expressing our gratitude and appreciation.

Dr. Herbert Friedmann, guest curator for the Beauty of the Beast, Animal in Art exhibition, is Director Emeritus of the Natural History Museum of Los Angeles County.

Ganesha, teak wood carving, Indonesia.



Great Auk, now extinct. The Museum's mounted specimen was collected before 1844.



THE ANIMAL IN ART...

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A playful lion peers out from a traditional Dahomey applique from the Republic of Benin. \$20.00

Rx TAKE ONE MASK

by Elizabeth J. Wright

Why does my body hurt? Why is my mind troubled? What or who has caused my illness? And most importantly, how can I be helped and who can help me?

Mankind is linked through the ages by a continuing chain fashioned of these questions and efforts to obtain answers.

The earliest evidence for such questions and hoped-for answers can be found in the form of a figure on the walls of the *Trois Frères* cave in France. Considered to be at least 17,000 years old, it is interpreted by Kurt Pollock in his book *The Healers; the Doctors Then and Now*, as follows:

We cannot say for certain that this masked dancer was a magic healer as well as a mere magician, but as masks of this type are worn by the medicine men of some primitive peoples today, it seems likely that this painting is the oldest known representation of a medicine man.

The need for a medicine man, Shaman, doctor, or healer, which appears in all known and studied cultures, indicates the mutuality of a single idea: that disease is considered abnormal. It is in an effort to return a sick person to a state of health that many healers wear masks.

Although the idea of healing masks is a common denominator among many people, the purpose of the masks, the variety of designs, and theories regarding the cause of illness differ radically.

Disease concepts fall roughly into three broad categories: first, *natural causes*, which include modern medical theory and all injuries which are obviously inflicted by material agencies; second, *human agency*, whereby disease is considered directly due to the malicious act of a human being, this includes sorcery; and third, *supernatural agency*, which embraces all actions due to

supernatural factors.

Among primitive people it is believed that the latter two categories attain the greatest adherence and may be narrowed down within these classifications to include: sorcery, breach of taboo, disease-object intrusion, spirit intrusion, and soul loss.

Within the cultures under consideration it is not believed that the mask of itself heals. However, used in a healing ceremony the mask effects for wearer and viewer a transformation of the natural into the supernatural. In *Masks and Magic*, Olive Riley describes the process:

Masked, the wearer no longer has human identity.... This magic of transformation is felt not only by the wearer of the mask. An all-pervasive magic transmits itself to the participants in the ceremony as well.

They feel the vibrant presence of the god or spirit because he has come to them through the powerful medium of the mask.

Through the use of masks demons are believed to be placated, souls rescued, or by a balancing of natural cosmic forces the sick are thought to be healed.

To a people living in one of the world's most hostile and bleak environments, exposed to excruciating cold with little in the way of compassionate natural resources, the ecstatic trance of the masked Eskimo Shaman has profound impact. The traditional Eskimo belief is that illness can be caused by evil spirits, the violation of social taboos, a foreign object in the body, or the loss of one's soul. The most dramatic concept is that of "soul loss" or "soul flight," the healing of which requires the skill of the Shaman and the use of masks.

The Shaman differs radically from the local medicine men and magicians, for his techniques are the techniques of ecstasy.

He is known as "the master of ecstasy."

From childhood the Shaman-to-be is often marked by a physical problem or difference in behavior. He can be eligible to the calling by heredity, but the arduous and horrendous experiences he must undergo to acquire Shamanistic powers make demands which reach far beyond hereditary status. His ability to endure and live through the self-imposed initiation is the final determination for all who wish to qualify.

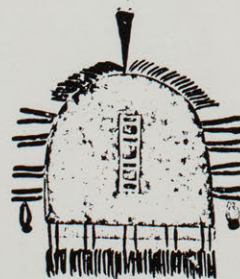
The initiation experience may involve removing the young man from the community. He is frequently taken by an older Shaman to a far distant place. Here a tiny ice house is built with only space enough to lie in and in which the young man must stay until he is rewarded with a vision. He is given one fur blanket for warmth, an amount of water to drink, then left to the mercy of the elements and animals. After a week goes by the older Shaman returns with more water. Again he leaves. It is during this time period of excessive privation, hunger, physical misery, and terror, that the young man may be rewarded with a vision.

The vision often involves the experiencing by the neophyte of his own death. This is usually of nightmarish proportions, his flesh being torn from his body by animals or grotesque beings. He must endure this psychic death, this devouring, with all its attendant pain before ministering spirits come to him, bring him back to life, and

Navajo

In deference to the Navajo people and the sacredness of rigidly traditional mask designs used in present-day ceremonies, a photograph of Navajo masks is not shown.

The accompanying artist's sketch suggests the shape and decorations for a mask worn by a male participant who represents one of the Yei, benevolent benefactors of the human race. The numerous Yei form combinations to remove every cause of indisposition.



This magnificent mask of wood represents a variety of sickness demons (*yakku*). According to one myth the demons and the *naga* (snakes) were the original inhabitants of Sri Lanka (Ceylon) living mainly in the northern and western part of the country. Their land was called *Nagadvipa* (Snakeland). UCLA Museum of Cultural History Collections. Photo: Robert Woolard.



cause him to experience a rebirth. These spirits then become his helpers for life. Their appearance may be abstracted from animal or human forms, but only he knows what they look like. Only he has the language which he can use henceforth in the healing trance states.

After such an experience the young man returns to his community and is accepted as a Shaman, but forever after he is separate from the rest of the community because of the intensity of his own religious experiences and the fact that he is the only healer who can deal with the human soul.

To understand the Shaman's function it is important to consider the cosmological beliefs of the Eskimo. It is thought that the sky, the earth, and the underworld are connected by a central axis. This axis passes through an "opening" through which the gods descend to earth and the dead to the subterranean regions. It is through this same opening that the soul of the Shaman, in ecstasy, can fly to celestial regions or to the underworld. However, the opening is perilously narrow, and only in a state of true ecstasy can a Shaman manage the dangerous passage.

When sickness strikes, a properly conducted seance is held during which the Shaman renders a diagnosis. If the condition and behavior of the afflicted one indicates a soul loss, it is the province of the Shaman to search out the soul and return it to its home within the body of the patient. Soul flight might be caused by dreams that frighten it away; the soul could be taken by a dead person seeking companionship; it might stray away from the body by itself.

The search for that soul involves all the techniques of the Shaman, including a condition of ecstasy. It begins with the Shaman undertaking radical purification. The patient and the patient's family also observe fasting and continence. The healing seance usually begins at night and the Shaman calls his spirit helpers by donning a mask. The mask serves to announce the incarnation of the mythical personage summoned.

To the accompaniment of drums and chanting the Shaman enters into the trance during which he and his spirit helpers search for the lost soul. Mircea Eliade in his book, *Shamanism*, gives an important distinction:

The Shaman's imitation of actions and voices of animals can pass as "possession." It is more accurate to term it a taking possession of his helping spirits by a Shaman. It is the Shaman who *turns himself* into an animal, just as he achieves a similar result by putting on an animal mask.

The journey in search of the soul may involve a terrifying flight to the moon, during which evil spirits are encountered: the Shaman's experiencing the awesome vastness of the night sky unto which he ascends and where dwells Sila, the Supreme Being.

During the seance the Shaman's body remains with the patient—writhing, twisting, dancing wildly with outstretched arms as though in flight. His voice emerges in gasps and a language is blurted out which is unknown to all others.

If he and his helpers do not locate the patient's lost soul on the moon, a dizzying descent is made into the depths of the sea where danger abounds. Here the Shaman and spirit helpers must placate Takanakap-saluk, Mother of Sea Beasts.

In the patient's dwelling the Shaman's body continues in its trance state, experiencing the engulfing dives into icy waters and coming near death by drowning.

An insight into ecstatic experience can be glimpsed by this trance song:

My body is all eyes
Look at it! Be not afraid!
I look in all directions!

On each step of the soul-recovery journey horrendous obstacles loom in the Shaman's struggle against the power of evil. Each obstacle must be overcome until the lost soul is recovered and the patient again made whole.

Inasmuch as the Shaman's spirit helpers appear to him alone in his initiatory trance state, it is necessary for the Shaman to carefully guide the mask maker in the crafting of his vision.

A study of these masks helps reveal the inner imagery of a Shaman during his period of initiation ecstasy.

The Eskimo Shaman's individualistic approach to the supernatural offers a direct contrast to that of the Navajo healer.

For the Navajo, who dwell in the arid regions of the Southwest, health and well-being is entirely a matter of maintaining a balance between the individual and his total physical and social environment. This is in addition to the maintenance of balance between the supernatural and man.

Traditional belief dictates that the world is inhabited by different beings, the most important being the *Holy People* and the *Earth Surface People*. The Navajo word for "holy" means "power which exceeds human effort," and this power also includes thunder, lightning, and whirlwinds. The *Earth Surface People* are the human beings alive upon the surface of the earth. It is believed that animals have both divine and human aspects. Ghosts, especially feared,

are interpreted as the malignant spirits of the dead. There is also a belief in witches, human beings with supernatural powers who are regarded as a source of evil. There is so little concern in the Navajo religion for any hereafter that in healing as in life philosophy the emphasis rests upon the here and now.

How does a Navajo lose the precious balance necessary to maintain health? By the infraction of rules of human conduct and by violating taboos or restrictions, things "dangerous to do." These include antagonizing ghosts, entering deserted hogans, the improper disposition of hair, nail parings, and feces. Corpses must be buried according to certain rules. Birds, snakes, bears, and reptiles should not be killed except under unusual circumstances. Anything lightning has struck becomes dangerous.

It is the function of the medicine man, also known as the singer, to bring the dangerous under control, draw out the evil, and attract the good and beautiful. In his way lies the restoration of new harmony between the individual and the total environment.

The power of the medicine man comes from many years of dedicated study. Learning the "sings" starts with adolescence since both men and women eventually participate in ceremonies which include singing. After a period of observation the older men select a relative or young man who is eager, bright, and has a good memory—necessary attributes for a Navajo medicine man.

According to Clyde Kluckhohn the religious life of the Navajo people is a major focus in their lives, with the average male spending one-third of his waking hours in religious pursuit; in attending sings, gathering plants for them, in helping with the sandpaintings or as a singer himself. The women, also, spend nearly as much time doing the same. Therefore, the requirements made of a medicine man for detailed and specific knowledge is apparent.

Extremely complex and time-honored rituals which he scrupulously observes are entrusted to him. The art of sandpainting used in healing ceremonies involves a system of symbolism almost overwhelming in intricacy. A thorough knowledge of hundreds of different plants and herbs and their uses is part of his responsibility. Unlike the Eskimo Shaman, whose highly individualistic ceremonial performances are revealed in ecstatic trances, the Navajo medicine man's power comes from his ability to accurately recreate all aspects of traditional complex ceremonials. Word-perfect is the requirement in the learning of numerous

prayers, songs, and chants. A knowledge of every procedure in a vast, ancient ceremonial heritage is the responsibility of the Navajo medicine man.

The concept of being out of balance and the need for restoration of harmony through proper healing ceremonies applies to both body and mind with no separation observed between physical and mental illness. The same is true regarding the world of religion, and the world of health.

When an individual becomes afflicted a diagnostician is summoned. The diagnostician is not a medicine man but one who enjoys a specific calling. The ability to diagnose is a power which can come suddenly to an individual during the course of a lifetime.

The actual act of diagnosis can be performed in a number of ways: through star gazing, response to noises of the night, or by hand trembling which is the most common. This involves a self-induced trance during which the fingers begin to tremble, convulsive movements run up the arm and terminate in a flailing of that member. During this procedure the patient's transgression of a particular taboo is revealed by the diagnostician. The patient then returns to his family and after consultation decides upon a particular medicine man singer.

A sing, or healing ceremony, can last from a few hours involving the singer, the patient, and a few kin, to a nine-day sing for which tribal members come from the 25,000 square mile reservation and thousands join in the ceremonial observances.

During healing ceremonies masks are donned by the singers who impersonate the gods. The most important figure is Yei-bet-chai, maternal grandfather of the gods. His headmask is a hood fashioned of white buckskin surmounted by eagle feathers and fringed with red horsehair. Depending upon the size of the ceremony many Yei (gods) appear, each properly masked. Frequently a mask is also placed upon the patient.

By the strict performance of the intricate, painstakingly-observed rituals, it is believed that the singers do not beseech the gods to restore balance, but by their skill and dedication they compel them. According to Adair and Deuschle in *The People's Health: Anthropology and Medicine in a Navajo Community*:

They are performing the very songs and rituals that the gods used to bring about creation. It is more than reenactment. It is the real thing, it is the laying of their hands on the machinery of the infinite and straightening it out.

The masks used in Navajo ceremonies are made from the skin of deer that are

smothered with pollen, not shot. If they were to be made from the hide of an animal shot by a bullet, the Navajos believe the wearer would die of fever.

Frank Waters, whose deep empathy with Indian life is reflected in his books and articles, speaks of the Navajo sings in this way:

Navajo ceremonialism is preoccupied with restoring harmony between the individual and the supernatural forces of the universe... Its specific function is the healing of illness.

The complex and exotic rituals of the traditional Ceylonese are especially apparent in their approach to illness and its cure.

Illness is believed to be caused by evil spirits or sickness-demons entering into a human body. However, these very sickness-demons can be rendered harmless or even induced to restore the patient to health by the application of the correct procedures. The exorcism of the sickness-demons is usually the province of masked actors and dancers including a priest-magician.

Because Ceylon (now Sri Lanka) lies on the periphery of the realm of Indian-Hindu culture it is thought that a number of the demon-sickness beliefs are of Hindu origin. One is related by Andrea Lommel in *Masks, Their Origin and Function*:

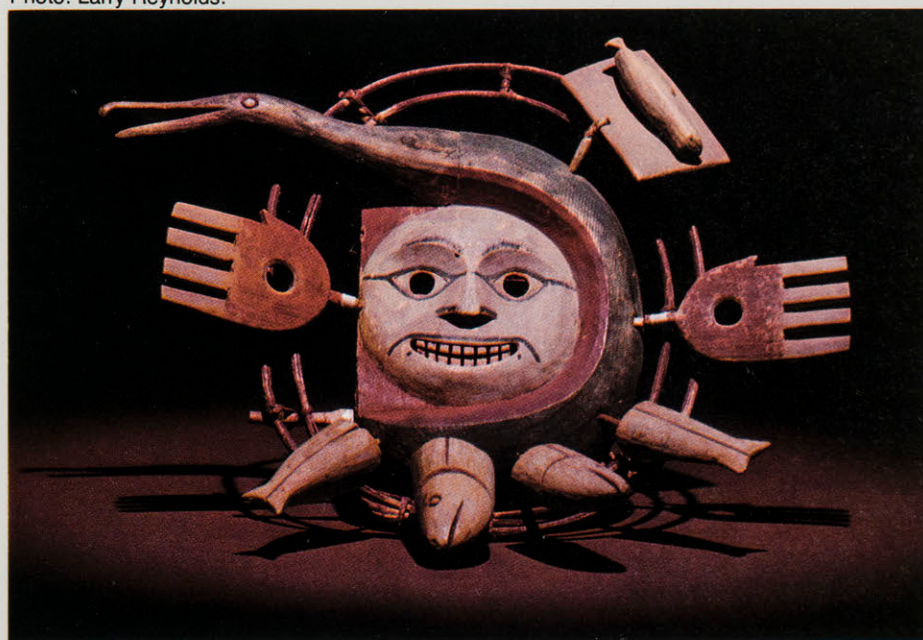
The demons' home is in a northern land called Uttarakurudivaina, where they are ruled over by a king named Vesamunurajurovo. The demons prowl around and lie

in wait for human beings in order to infect them with illness. They also hope that people will "give them food," that is to say, make sacrifices to them. In olden times the spirits used to kill human beings and devour them until the chief god, Sakra, and the Buddha spoke out against their wicked behaviour and forbade them this practice. But as the demons were very powerful, the two sides reached a compromise agreement—it would be described as an agreement between the powers of light and of darkness. The demons were no longer allowed to kill human beings, but could make them ill. However, they were also bound to remove the sickness they had caused after proper sacrifices had been made. The demons had to accept these conditions in return for being allowed to keep at least some of their power.

Another story incorporates the creation of a ruling sickness demon, the *kola-sanniya* and his band of servant demons, or *yakku*. Each *yakku* can cause a specific illness to the person selected as a victim.

It is believed that every *yakku* has a favorite spot in which he lingers during the day or night. It is in this spot that he awaits his victim, assuming the guise of either a man or an animal. In this type of encounter a *yakku* does not physically injure his victim, but causes shock from which physical reaction later results.

The Eskimo Shaman frequently creates his own mask. It is his special responsibility to return to the time of origins—that realm in which man and the animals, the living and the dead, man and the gods, were one. The individual response of each Shaman results in highly individualistic masks. LACNHM Collections. Photo: Larry Reynolds.





Female Corn Husk Ceremonial Mask. A legend upon which secret societies are based and at which corn husk masks are worn tells of a traveler who met thirty strange people in the woods, each wearing a corn husk mask which grew naturally upon him. These masks are also hung outside the door of a home for protection when feasting is in process. Southwest Museum Collections. Photo: Larry Reynolds.

In the Ceylonese healing rituals each of eighteen diseases is personified as a sickness-demon and is visually portrayed by a specific mask. The dancer who wears a demon-sickness mask must perform a traditional ritual ceremony to placate this evil spirit. By donning the mask he calls the demon into being.

The belief is that the dancer has concluded a "pact" with the demons, under the terms of which human beings are given the right to use the demons' faces. These faces may be worn as masks. The ceremonial dance calls the demon forth to acknowledge the pact and free the afflicted from its malignant influence.

During the healing ceremony as the drums and music grow wilder and wilder, the masked dancer abandons himself to frenzy in an attempt to summon the demon. When this finally occurs, the dancer faints as the demon leaves the sick person to enter the dancer's body. The dancer, still masked, is carried out as dead and the patient is considered cured.

When an individual suffers a disposition to illness it is called, in Singhalese, *tanikama*. This means "separateness" or "aloneness." It is in this ceremony where the priest-magician officiates. His responsibility is not only to placate the sickness-demons,

Doorkeeper and Doctor Mask once owned by Chief Edward Complanter. The preoccupation of the Iroquois mask carver is with dramatic effects rather than sculptural form. When authorized to make a new mask the carver traditionally selects a basswood tree. Before cutting into the wood of the living tree he prays to its spirit, offers incense and 'feeds' the tree with tobacco. After carving, the mask is carefully separated from the trunk so that the tree does not die. Southwest Museum Collections. Photo: Larry Reynolds.

A Shaman's mask can announce the incarnation of a mythical personage such as an ancestor, mythical animal, or god. By the use of costume and mask the Shaman is transformed into a supernatural being who is responsible for heroic struggles against the "powers of evil." LACNM Collections. Photo: Larry Reynolds.



but to bring the patient back into the sustaining and positive influence of the community.

To accomplish this he orders friends and relatives of the patient to assemble at a particular hut which he has built. The hut contains eighteen sections and is located near the patient's own dwelling. At sundown guests assemble and the sick man is carried out, then placed on a litter near the magician's hut. To the accompaniment of drums the priest-magician appears as a fantastically costumed and masked dancer.

Approaching each of the eighteen sections of the hut he offers gifts to the demons within. The magician has eighteen masks. Entering the first section he dons the mask of the first demon, then approaches the patient with gross movements and shouts. His purpose is to drive out the first demon should this demon be hiding within the patient's body. This ritual is continued, utilizing all the masks one at a time, and continues throughout the night. By dawn it is believed that all the sickness-demons have been driven out of the patient and he is again embraced as part of the community.

With the Devil masks the Ceylonese have produced some of the most intricately-fashioned and magnificent pieces of art in the world. Usually of carved wood, they are painted in brilliant colors, yellow and red predominating. Some masks are of composite type and of enormous size.

The Iroquois, of historical prominence during American Colonial life, are an Eastern Woodlands people whose ceremonial healing practices and beliefs closely parallel other cultures. However, the differences are marked.

The Iroquois world is occupied by a host of invisible spirits. While the Great Spirit indirectly guides the lives of men, this Great Spirit cannot be reached directly through the appeal of men. The numerous lesser spirits can and must be contacted. The supernaturals of good include Hino (rain-bringer), Gaoh (spirit of winds), and Three Sisters (spirits of maize, beans and squash). The supernaturals who bring pestilence and illness to men are under the control of the Evil Spirits.

One of the organized groups of evil supernaturals is known as the False Faces. These False Faces bring sickness, death, and destruction. However, these same evil spirits are obliged to remove the sickness when the proper masks, dances, and ceremonies are performed. This is similar to the belief in "sickness-demons" who turn into "helping spirits" as that held by the people of Ceylon.

But unlike the Ceylonese who feel they are unjustly victimized by an evil spirit, the

Iroquois tribal member believes his sickness has been caused because of his own failure to observe or perform certain duties prescribed by the tribe. As a result the demon has attacked him.

This is close to the Navajo belief in spirits who cause illness, except that the Navajo attributes his ill-health to the breaking of a taboo. However, the Iroquois believes his illness to be caused by omission rather than commission.

One especially unique aspect of the Iroquois healing ceremony is the necessity for the patient to recall and to confess to an omission of duty. If he does not observe such confession any effort to heal is considered futile.

The healing ceremonies are the province of the Brotherhood of Medicine Men, known as "False Face Societies." Membership in the society involves people who dream that they are members. One leaves the society by dreaming that he is no longer active. It is strictly a male group except for one woman, The Keeper of the False Faces. Safekeeping of all False Face ceremonial paraphernalia falls into her hands. She is the one person entrusted with knowledge of current membership.

The duties of the False Face Society involve curing illnesses and keeping evil spirits at bay.

During early spring, late fall, and mid-winter the False Face Society performs public rituals of exorcism from house to house, ridding the village of evil and dangerous spirits.

In the case of an individual illness, if a person suffers with a disease which is often treated by the society, and if he dreams of the False Faces, this is considered a sign that he can be cured by False Face Society ceremonies. This group has a reputation for its ability to cure nosebleeds, toothaches, swellings, and eye inflammation.

When someone desires a cure the Keeper of the False Faces is notified and she assembles the members. Each member wears a face mask and a blanket and carries a rattle made from turtle shell. The ritual involves sprinkling the patient with hot ashes, the performance of ritual dances, and music.

The False Face masks of the Iroquois are marked with consistent characteristics which include grotesquely twisted features. The noses are usually bent, the arched brows are wrinkled. The mouth is the most variable part of the face. It may be turned up in a smile or grimace, or it may be oval-shaped for blowing hot ashes, a part of the cure. The tongue may protrude.

One of the Iroquois legends out of which

the form of the mask evolved explains the grotesque features:

Agos ago the only being on this continent was one False Face, who refused to move when the Creator told him that other beings were coming to live there. The Creator ordered him to look away while He marked a line on the ground to separate their lands. False Face turned away but kept peeking, until at last he turned around completely. The Creator caught him in the act and struck him such a blow that his face was knocked out of shape. And so it has remained to this day.

The False Face mask is carved from a living tree, usually the basswood. When the carver is authorized to make a new mask, he carefully selects the tree, prays to its spirit, and burns tobacco at its base as an offering. He then proceeds to carve the face directly on the living tree. After that the block of wood containing the mask is moved carefully so that the tree does not die. After the completion of the carving it is painted red if the tree had been selected in the morning, or black if selected in the afternoon. The preoccupation of the carver is with dramatic effect rather than sculptural form.

Twelve mask types have been distinguished: crooked-mouth; spoon mouth; hanging mouth; tongue protruding; smiling; whistling; divided half red, half black; long nose; horned; animal; blind masks. Some represent young, some old men with white hair and wrinkled faces. Wigs of streaming horsetails, metallic eye orbits and the show of teeth add to the dramatic effect of these masks, the purpose of which is to repel dreaded spirits while attacking them with ferocity.

The mask styles are dictated by the dreams, visions, and imagination of the carver, one who has spiritualized his relationship to the materials used in ritualistic observance.

The primitive mask used in healing had reasons for use—psychological reasons intertwined with basic religious and social beliefs.

According to Western thought the modern surgical mask has scientific reasons for use: keeping germs in check and preventing the spread of disease.

The psychological impact of early ritual healing was so much stronger than certain aspects of our own healing practices of today that modern man might well look back over his shoulder for directions into a more encompassing, compassionate future.

Elizabeth Wright is a regular contributor to TERRA. She is the author of a number of plays, TV scripts, and specialized articles.

Fossils as seen through x-ray eyes

by Wilhelm Stürmer

The first radiographs, or X-ray photographs, of fossils were made nine months after X-rays were discovered by Professor W. C. Röntgen in 1896. In the decades that followed, several paleontologists applied the technique with varying degrees of success. A laboratory devoted to X-raying fossils was created in 1932 by W. M. Lehmann, a German physicist, who left about three thousand radiographs of fossils when he died.

X-raying fossils differs from X-raying human beings. The long exposures are no problem since the fossils don't move and the large doses of radiation do no damage. Spectacular results now are possible using special equipment such as an X-ray tube with a fine focus that will show fossils smaller than five microns (five one thousandths of a millimeter).

For twenty years, I have run a program for X-raying fossils with modern radiographic equipment, high-resolution photographic materials such as those used by the electronics industry to make integrated circuits,

and electronic image processing. With financial help from the Volkswagen Foundation and a grant from the German Research Society, I equipped a van with an X-ray unit, a T.V.-Chain, and a Siemens image processing machine. I then could drive this mobile laboratory to a fossil locality and X-ray likely pieces of rock on the spot. The best specimens were taken later to the Siemens Corporation laboratories for further examination.

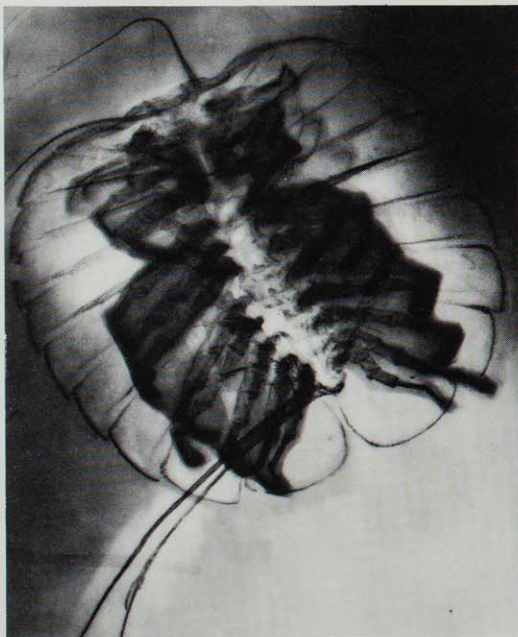
My most surprising results came from fossils about 380 million years old found in a black shale of Early Devonian age in Hunsrück Mountains west of the Rhine River. This shale long has been quarried for roofing and was known to contain fossils such as starfish, clams, trilobites, and fish.

Fossilization had converted most of the animals into the mineral pyrite, a sulphur compound of iron chemically written FeS_2 . Pyrite absorbs X-ray quanta much more readily than shale, which was advantageous for X-raying. The pyritized shells and bones of the fossil marine animals show

clearly in radiographs and in some cases it is possible to see soft parts of the animals such as intestines, stomachs, eye interiors, tentacles, and even muscles. Many of these structures never had been seen in fossils.

I now have about twenty thousand radiographs of seven thousand fossils, many of which have been described in scientific papers that permit us to understand life of the past more fully. This work still continues and I expect further spectacular results when the technique is applied to pyritized fossils from other parts of the world.

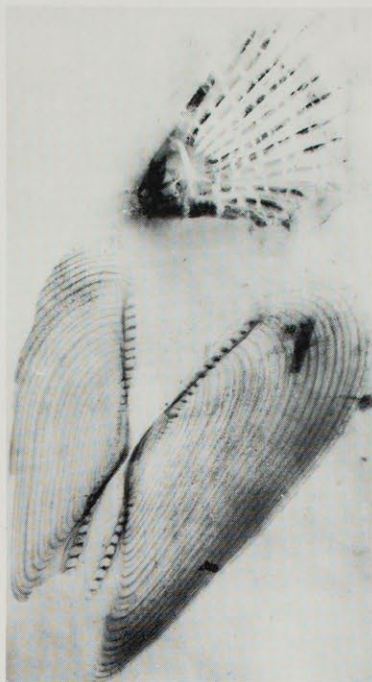
Wilhelm Stürmer is director of Research and Development at the Medical Division of the Siemens Corporation in Germany, and honorary professor of paleontology at the University of Mainz and at the University of Erlangen-Nuernberg. Seventy of his most spectacular radiographs will be on display in the museum from January 15 through April 15, 1978.



Cheloniellon calmani Broili, 1932, an arthropod of uncertain affinities, showing antennae and other appendages. Original about 4 inches long. Early Devonian age, West Germany.



Triarthrus eatoni (Hall, 1848), a trilobite showing rarely seen antennae and other appendages. Original about $\frac{1}{16}$ inch long. Silurian age, New York State.



Ctenodonta cf. *C. subcontracta* Beushausen, 1895, paired valves of a clam lying beside *Zaphrentis* sp., a solitary coral. Clam about 4.5 inches long. Early Devonian age, West Germany.



Asteropyge sp., a trilobite showing lenses of the compound eyes, intestine, and other structures. Original about 2.5 inches long. Early Devonian age, West Germany.



Lobobactrites sp., a shelled cephalopod showing the chambers of the shell, from which tentacles protrude. Original about 3 inches long. Early Devonian age, West Germany.

Christmas in July

by Ralph W. Schreiber

Christmas Island lies twelve hundred miles south of Honolulu, Hawaii at two degrees north latitude and 157 degrees west longitude. The roughly boot-shaped island has a perimeter of 105 miles and encloses approximately 250 square miles of land and 135 miles of lagoons and enclosed saline lakes. A thirty-four foot high sand dune along the windward reef is the highest point above sea level; the average elevation of the island is only about three feet. As a biologist with the Pacific Ocean Biological Survey Program, I spent nine months of 1967 on Christmas Island, studying the biology of the eighteen species of seabirds that nest in huge colonies on this coral atoll. I come from hilly northcentral Ohio and the stark flatness and openness of an area this size was new to me. In lagoon areas at lowtide, the exposed mud-shell flats extend

View of the coconut plantation and military barracks.



to the horizon. Covering much of them is a three to five inch thick hard-pan of coral, with shell and calcareous debris underneath. On several occasions my Land-Rover broke through the hard-pan and I had to spend hours extricating it. I soon learned to avoid driving in these seemingly safe areas.

By surveying the scanty available literature about the island and talking with Dudley Cook, the British Resident Commissioner there, I learned something of the history of the island. Captain James Cook named it Christmas when he landed on 24 December 1777 from his ships "Resolution" and "Discovery" during his third voyage to the Pacific. Cook commented in his journal on the large number of birds, crabs, lizards, and rats present. Archaeological evidence and the presence of rats in the late 1700's indicate that people must have visited the island in earlier times. However, no indigenous human population exists.

During the 1800's, various companies mined guano from the nesting seabird colonies. The guano was used as an organic fertilizer. Whalers rested there and replenished their food supplies from the abundance of turtles, fish, birds, and eggs. All early commercial guano mining ventures failed, however. The 1873-1875 United States North Pacific Surveying Expedition charted the island. In 1902, Lever's Pacific Plantations Ltd. received a British lease and planted some 70,000 coconut trees.

In 1914 Father Emmanuel Rougier, a priest who lived on the island, published a complete description of the flora and fauna in an attempt to interest further development for profit. In 1921 the Whitney Expedition of the American Museum of Natural History investigated the island's biology. Between 1942 and 1948 American forces occupied the island against possible Japanese invasion; their barbed wire, tank traps, and outposts are still evident. During the war years the Gilbert and Ellice Islands Colony planted coconut trees on Christmas, and the plantation continues today. They had imported approximately 400 Gilbertese people to work on the plantations when I was there in 1967. Now this population has grown to more than a thousand people.

The British government tested nuclear weapons in 1958-1959 and the Royal Air Force maintained a base there until 1964. In 1962-1963 the United States Atomic Energy Commission used the island for bomb testing. The Environmental Science Services Administration's Satellite Triangulation Division occupied a site on the island in 1967 for photographing satellite positions,

and I lived with this group during my stay.

The cultivated coconut palm (*Cocos nucifera*) dominates the island vegetation. From the approximately 800,000 bearing trees, the Christmas Island Plantation annually harvests and ships 500,000 pounds of copra (dried coconut meat). Production is decidedly affected by rainfall. Approximately eighteen months after a rainy period the trees produce more and bigger nuts than after dry periods. The only other exports from the island consist of dried fish (sent to the families of plantation workers in the Gilbert Islands) and various native handiwork such as feather fans, pandanus leaf mats, and shark-tooth decorated walking-sticks made for visiting "Europeans," as all white men are known to the natives. Uncultivated plants include several grasses (*Lepturus*, *Eragrostis*), large bushes (*Messerschmidia*, *Scaevola*, *Pluchea*), and some low-growing succulents (*Tribulus*, *Portulaca*). With only about twenty inches average annual rainfall, the island does not support a luxuriant growth, but after hard rains the plants briefly burst into bloom.

Other than the coral skeleton which forms the island, land crabs (three to six inches in size) are the most prominent invertebrate present. After a rain shower or in the evenings these crabs cover the roads so densely that it was impossible to drive my Land-Rover without squashing many. One evening I counted the number I hit, while trying to avoid them, in an eleven-mile

stretch: over 700. The dried claws of this crab are capable of puncturing an automobile tire, a fact to which I can sadly attest: in one week these claws caused six flat tires. These crabs dig deep burrows and all dirt roads on the island are filled with their holes, making driving bumpier than on any "washboard" road at home. When Father Rougier slept on the ground in 1909 he complained of crabs tugging at his beard and ears. Luckily, the crabs didn't know how to climb onto my cot. However, the noise as they crawl along the wood floors of the barracks at night is enough to make one think the island is haunted.

One of my favorite nighttime activities was catching an edible arthropod. Using headlamps and Coleman lanterns, one walks the fringing reef at low tide looking for the eye reflection of *Longusta*, or crayfish. If stalked properly and grasped firmly, this clawless relative of the lobster can be exciting hunting. However, if grabbed carelessly, the animal will flip its abdomen and disappear into deep water. The natives are expert crayfish hunters, but one learns the proper technique only with much practice. In two hours hunting on a good night, four or five natives easily caught fifty or even one hundred crayfish. To natives and visitors alike this animal is a delicacy, and the excitement of catching them adds to the pleasure of eating.

The island vertebrate fauna during my stay on Christmas was limited to one nondescript dog in the village, numerous feral

Sooty Tern (*Sterna fuscata*) colony on the north west point of Christmas Island.



cats, two reptile species (Mourning Gecko and Snake-eyed Skink), some Polynesian rats, and nineteen species of breeding birds. The surrounding ocean and lagoons supply the natives with tuna, swordfish, bonefish, and mullet in almost unlimited supply. The labor of supplying the family with food almost becomes a sport in which all ages share.

The bird populations of Christmas Island are diverse and fascinating. From terns to boobies to frigates to tropicbirds, each species occupies its own niche in this tropical community, so that at any time of the year some species is nesting: an ornithologist's paradise.

Sooty Terns (*Sterna fuscata*), by far the most abundant species of bird on the island, nested during my stays in June–July and again in December with an estimated population of fourteen million adults in each period. In three weeks at the start of nesting in June, the natives collected and ate approximately 250,000 eggs from one colony near London, on the northwest tip of the island. I estimated this number by counting the number of eggs the buckets held and with the help of the resident commissioner and several natives estimated the number of trips made to collect eggs.

Although Christmas Island is a bird sanctuary, the people have been allowed, in the past, to collect Sooty Tern eggs. These provided a valuable food source and supplemented an otherwise monotonous diet. The natives are expert at telling the age of the eggs and only collect those laid the previous night. Egg collecting was halted after a certain period each year so the terns could raise some young.

Seven Sooty colonies existed on the island by mid-July, the largest of which con-

tained an estimated 800,000 eggs within a quarter square mile. Available information suggests that Christmas Island may be the world's largest Sooty Tern colony.

Two unusual facts about this Sooty population are interesting. First, the terns nest every six months rather than on the more usual annual cycle, and second, the colonies appear particularly unsuccessful in producing fledglings (at least in the summer of 1967). Dr. N. Philip Ashmole of the University of Edinburgh showed that if a pair of Sooties on Christmas Island successfully raises a chick in one breeding season, they return a year later to nest again. If unsuccessful, however, they return to the island six months later to nest again.

Christmas Island and several nearby islands are the only locations in the world where bird populations are known to breed on such a schedule. This breeding schedule probably occurs due to the absence of any distinct known seasonal variation which might control breeding, such as day length, temperature, or food availability.

Great Frigatebirds (*Fregata minor*), who cruise over the Sooty colonies snatching young chicks to feed their own nestlings, greatly diminish the Sooty productivity. Daily, when the tern chicks were hatching, I counted twenty-five to 150 frigates over the colony. All Sooty chicks in one colony were gone by mid-August, long before fledgling age was reached. I collected regurgitated food from frigatebird nestlings and found that during July, half the samples contained partially digested Sooty Tern chicks. With such high predation, it is amazing that these terns nest at all on Christmas Island.

Frigatebirds are not only adept at catching young terns, but they are also daring pilferers from other birds and from the na-

tive people fishing in the lagoon. The young frigates hover over a fishing party and when the opportunities arise, actually try to take fish out of the gill nets. Frigates prey on the three species of boobies on the island (Blue-faced, Brown and Red-footed), by chasing the boobies until they regurgitate their catches. The agile frigates then catch the dropped fish and eat it themselves. However, an analysis of the food eaten by boobies and frigates indicates that frigates primarily feed for themselves at sea. The chasing behavior may be of value for food getting during times of food shortage.

One of the projects I plan to work on in the future on Christmas is an investigation of the clepto-parasitic habits of frigates and trying to solve some of the mysteries of this species' interactions with other birds.

Not all the frigates on Christmas Island fare as well as the Great Frigatebird. In 1958 Michael Gallagher reported a colony of over 500 nesting pairs of Lesser Frigatebirds (*Fregata ariel*). In the same area I found only sixty-eight nests in 1967, and none of the chicks which hatched lived more than fifty days. Cats ate them all. With continued predation, this species may well no longer nest at all on Christmas Island. I am anxious to return to determine their fate.

Most other bird species do not nest on the mainland of the island, and all nesting is confined to small islets in the lagoon where the birds are relatively safe from predation by cats. Through ignorance of basic ecology and the balance between predator and prey, man introduced a predator—the cat—which threatens to eradicate at least one species of nesting sea bird.

It is interesting that these bird populations have survived the operations of various war activities on the island, and especially the atomic bomb testing, only to be threatened with extinction by feral cats. Who would have thought that an unthinking act, like liberating cats on Christmas, could have such potential for damage to the birds? Additionally, now that a tourist hotel has been built here and the native population has increased, with all the attendant disturbance, it will be difficult to protect the native birds and their habitat.

Certainly the next few years will be a critical test for this tropical coral atoll and its fragile ecosystem.

Ground Zero: above this spot many of the atomic bombs were exploded. Radioactivity is now almost non-existent.



Dr. Ralph Schreiber is Curator of Ornithology at the Natural History Museum of Los Angeles County. In 1967 he spent nine months on Christmas Island studying the biology of seabirds that nest there, a project he hopes to continue.

Just hatched and still wet nestling Sooty Tern
(*Sterna fuscata*).



View of Manulu Lagoon on the north-east point
of Christmas Island; the islets support many of
the nesting birds free from cat predation.



Lower right;
Bagging the dried copra for ease in transfer to
the cargo freighter that stops every six months.

Immature Great Frigatebird (*Fregata minor*)
attempts to take a fish from the Gilbertese
fishermens net.



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